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ABSTRACT

One English speaking child's phonological, semantic, and syntactical development from 15 to 21 months old is detailed in order to investigate the development of the mid vowel categories in English as reflected in spontaneous speech production. Prior research on this topic is summarized to reveal certain trends in the development of mid vowels. This study compared the child's four basic categories of vowels with the full range of an adult's in order to determine correspondences. Realization rules based on these correspondences were postulated. These rules accept adult surface forms as input and give the child's sound categories as output. These are shown to be functionally related. The pattern of mid vowel development from Stage I to Stage II suggests that these vowels can be described by the term regression. It is concluded that phonological acquisition is characterized by an interaction of the inventive nature of the child and the inherent constraints on the phonological category system. (PMJ)

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REGRESSION, SURFACE CONSTRAINTS AND THE ACQUISITION OF MID VOWELS

Ronald P. Schaefer

Abstract: Few studies in the phonological development of child speech have focused on the acquisition of vowels. The present paper will deal with the development of the mid vowel categories of one English speaking child. The realization rules which account for the correspondence among the adult-child vowel categories are shown to be functionally related. Further, the pattern of mid vowel development from Stage I to Stage III suggests that these vowel categories can be described by the term regression.

Within the last ten years a variety of studies investigating the development of the human phonological capacity have appeared. These studies range from theoretical statements on phonological development to experimental investigations of its specific aspects. Within this range are also found studies which attempt to analyze by means of a collected sample of spontaneous speech data the structure of a child's phonological system. Despite this variation, a clear majority of developmental studies have focused on the acquisition of consonant segments.

In contrast to the majority of previous developmental studies, the present study will attend to the acquisition of vowel segments, in particular, the development of the mid vowel categories in English as reflected in spontaneous speech production. Already available studies dealing with vowel development in English speaking children will be discussed as well as possible implications for phonological development which may be supported by the findings of the present study.

The data to be discussed were obtained from one English speaking child, C, the oldest of two children. The details of C's phonological development, as well as that of her semantic and syntactic development, were catalogued on daily note cards by her mother, who, along with her husband, speaks a General American English dialect. Certain stages of C's phonological development were recorded on cassette tape although the present study does not rely on this taped material. What follows, therefore, should be considered as an initial analysis of the available data on C's phonological development.

C's first non-babbling sounds to which consistent and identifiable meanings could be attached began at about 14 months of age. The data to be discussed here however were obtained from the period from November 1, when C was 15-1/2 months to approximately April 15, when C was 21 months. Additional information on C's development which may be of interest is that C's spontaneous vocabulary at 15-1/2 months consisted of 19 words while one month later her productive vocabulary consisted of 51 words.

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Despite the general neglect of vowel acquisition studies noted above, some investigators have attempted to trace the development of vowel categories in English. Albright and Albright (1956), for instance, compile the findings of an analysis of a 26 month old child. Though the child's sound categories at this age were nearly consistent with those of an adult, Albright and Albright (1956) noted certain correspondences between the adult and child categories. (Throughout this paper | | represents an adult's category, / / a child's category and [ ] a phonetic segment.) / ɔ / corresponded to |ai| when preceded by a bilabial consonant, /u/ corresponded to |ʌ| when preceded by |f| or |s| and /o/ corresponded to |u| when followed by a voiced velar consonant. The data, though meager, suggest that the realization of mid vowel categories, even in the later stages of development, seems to be conditioned by the consonant categories of the immediate environment.

One of the earliest investigations of phonological development expressly concerned with sound categories is reported in Leopold (1953). This report is based on a fuller investigation in which Leopold provides month by month progress of the phonological development of his daughter Hildegard, who was raised in a bilingual English-German environment. Leopold (1953) assumes that a child's consistent replacement of a sound category found in the adult system by some other sound category is evidence that the replaced category does function in the sound system of the child.

As for Hildegard's vowel development, it follows in general an expected path. After the categories of the well known vowel triangle /i,u,a/ (where /u/ was only experimentally supported) were established, /u/ at 11 months was replaced by /e/. The resulting three vowel categories persisted until 18 months when /u/ achieved a stable level.

A number of adult-child correspondences involving mid vowel categories are reported in Leopold (1953).Between 11 and 18 months the correspondences reported are |o|:/u/, |o|:/a/ and |o|:/au/. No mention of possible conditioning factors is provided. At 23 months there is an |o| : /ɔ/ correspondence in stressed syllables and there is an |ʌ|:/a/ correspondence up to 28 months. At an unspecified time after 28 months, the categories,/ɛ/ and /æ/ are acquired. Relying on the schedule of vowel correspondences found in Leopold's (1953) discussion, it might be inferred that mid-vowel categories do not develop as a system but rather independent of each other.

An often cited source of data on phonological development in English is Velten (1943). Influenced by Jakobson (1941), Velten analyzed the phonological development of his daughter, Joan, who was raised in a Norwegian-English-French environment.

Velten (1943) notes the regular correspondences between adult and child categories in stressed syllables as well as the role consonant segments may play in conditioning derived vowel categories. At 15 months /a/ and /u/ establish an initial vowel contrast which is then expanded to include /aɤ/ and /uɤ/. During this later stage, a number of

adult-child correspondences signal the various consonant properties that are not realized in the child's surface forms but that the child apparently has access to in deriving those surface forms. For instance, adult /ɛ/ corresponds to /a/ before sonorant consonants and to /u/ before obstruent consonants. In another reported instance /æ/ and /ɔ/ corresponded to /a·/ before voiced consonants and to /a/ before voiceless consonants. The notion of an underlying level of representation to which the child has access was not explictly entertained by Velten (1943), but such a level has been entertained in recent years and appears applicable to the Velten data.

Of the correspondence sets remaining, each follows what has become a fairly predictable pattern. /ɪ/ and /ʊ/ correspond to /u/, /a/ to /a./ and /i,e,o,u/ correspond to /u./. According to Velten (1941) the adult category /o/ prior to 23 months corresponds to /u/ and /a/. /i/ becomes established at 36 months while other vowels become integrated into the category system in the sequential order /e,ɛ,o, ɔ,æ / at about 42 months. Such a progression of development conforms with the notion that mid vowel categories develop after the high vowel categories but before the low front vowel category.

A third source of data on the acquisition of vowel categories can be found in Burling (1959). Burling (1959) discusses the sound category system of his son Stephen, who beginning in his first year lived in a linguistic environment dominated by Garo, a Tibeto-Burmese language and English. By 19 months the five vowel categories /i,u,e,o,a/ were tentatively established. For the following six month period, however, the mid front category /e/ corresponded to /i/ and /ai/. Instances of the other mid vowel category /o/ were apparently heard at 19 months, but /o/ was not recognized as a category until 21 months. It would seem, based on Burling's (1959) discussion, that the mid vowel categories appeared initially at 19 months but did not become integrated into the sound system until a later stage of development.

A more recent discussion of vowel category development can be found in Braine (1974). Braine, a native of South Britain living in the United States, discusses vowel category development in terms of feature acquisition at the morphophonemic or lexical level of structure. Braine (1974) reports his son Jonathan using his first word at 15 months and shortly thereafter he attributes five vowel categories to Jonathan's phonological system, /a/, /o/, /i/, /u/, and /ai/. At 19 months the categories /ɑ/, /ɒ/ and /ɒu/ are attributed to Jonathan and by 20 months the full complement of tense /lax vowel categories are established. At 22 months / æ/ is an established category.

Braine (1974) argues that phonological development is characterized by a progressive increase in control over phonological features. Within Braine's (1974) feature framework, Jonathan's /a/ category at 15-18 months was specified as [-complex nucleus, -high, -round] and his /o/ category as [-complex nucleus,-high,+round]. At 19 months, with the additional vowel categories noted above, /a/ was specified as [-com-

plex nucleus, -high, +low, -round] while /o/ was specified as [complex nucleus, -high, -low, +round]. Jonathan has thus gained progressive control over the feature [low]. Braine (1974) complements the preceding feature specifications, attributed to the child's underlying level of representation, with appropriate redundancy rules, such as the following for 19 months:[+round] ⟶ [+back]. Braine's(1974) discussion, in contrast to those above, does not attend to adult-child vowel correspondences and appears to be at odds with the notion that the child's underlying representation is a near copy of adult surface forms.

Supported by the above limited discussion of the acquisition of vowel categories, certain trends in the development of mid vowels can be observed. The mid vowel categories, first of all, seem to follow a progressive line of development whereby they are acquired after /i,u,a/ and before / æ /. A second trend observed suggests that the mid vowel categories may undergo a prolonged period of development between initial appearance and integration into the category system. A third trend which might also be noted is the role consonant segments may play in conditioning the appearance of certain vowel categories.

The present study appears to be in contrast to those studies previously discussed where either a nearly adult-like vowel system was examined, as in Albright and Albright (1951), or where only passing attention is given the development of mid vowel categories. As earlier stated, the data to be discussed are based on sound correspondences between adult surface categories and categories derived from the child's speech production. Such a procedure seems analogous to the study of borrowing whereby one infers features of the structure of the borrower's phonological system from his production of borrowed lexical items.

It ought perhaps to be noted at this juncture that not all of the data to be discussed can be strictly classified as spontaneous speech. Some portion of the data might more appropriately be classified as imitations. However, following the precedent set by Ferguson and Farwell (1975), imitated forms in the data have been included for discussion. Ferguson and Farwell (1975) argue that imitations ought not be excluded from consideration as phonological data. For instance, they argue that the separation of imitated forms from spontaneous forms does not correspond to a separation of different forms of the same word. Ferguson and Farwell (1975) also point out that no explicit definition of imitation is feasible given that children imitate adult utterances at time intervals far removed from the adult spoken form.

Given these methodological assumptions, the discussion of C's vowel category development can proceed. C's vowel system from about 17-1/2 - 20 months appeared to consist of four basic categories. Consider the correspondence sets based on those adult forms in the data identified as containing the four basic vowel categories. Table I contains samples of the forms in their respective correspondence sets. Notice in Table I the two additional correspondence sets representing

complex vowel categories. These two complex categories were placed with the basic category /a/ since the initial member of the complex was /a/. As can be observed from the data in Table 1, the child categories /i/, /u/, / æ/ and /a/ appear as regular members of the individual correspondence sets from 17-1/2 to 20 months.

|iI| : /i/		|au| : /au/		|u| : /u/
see	[si]		shower	[saw]	boot	[bu]
bead	[bi]		house	[haw]	room	[bu]
|æ| : /æ/				|a| : /a/
man	[mæ]		|aI| : /ai/		dog	[ga]
nap	[næ]		cry	[bay]	on	[ha]
			ride	[way]		

TABLE 1

Partial motivation for positing four basic categories comes from the correspondence sets involving the remaining adult surface categories. Consider the correspondence sets for the adult categories |u| and |ɪ| shown in Table 2. As can be observed, the adult category |u| corres-

|ɪ| : /i/		|u| : /u/
big	[bi]	wood	[wu]
fit	[fi:]	cookie	[Ku]
in	[hin]		

TABLE 2

ponds to C's category /u/ and |ɪ| to C's category /i/. One might, based on such correspondence sets postulate what Smith (1973) has called "realization rules". Realization rules accept adult "surface" forms as input and give the child's sound categories as output. With regard to the adult categories |u| and |ɪ| it would appear that they are subject to a realization rule, or rules, with /u/ and /i/ respectively as output.

Additional motivation for positing four basic vowel categories is obtained from the behavior of mid vowel categories. Perhaps the least interesting of the mid vowel correspondence sets is that of |e| . The data in Table 3, which contains the appropriate correspondence set sug-

/el	:	/i/
cake		[gi]
bracelet		[bi]
name		[ni:m]

TABLE 3

gests that /el regularly corresponds to /i/. A second realization rule might thus be postulated, with the following tentative form (→ indicates "is realized as").

$$1.\quad \begin{bmatrix} V \\ -back \\ -high \\ -low \\ +tense \end{bmatrix} \rightarrow [+high]$$

The correspondence sets for the adult mid vowel categories other than /el appear somewhat variable. Nonetheless, the correspondences appear to be principled. Each of the remaining adult mid vowel categories will be examined in turn.

In contradistinction to the adult categories which show one correspondence set , /ɛl appears to show two correspondence sets. Table 4 contains some characteristic forms from the data. According to Table 4,

/ɛl	:	/i/	/ɛl	:	/ æ/
bear		[bi] ~ [bəbi]	wet		[wæ]
stair		[di]	necklace		[ræ]
hello		[iyaw]	head		[hæ]
elbow		[hibi]	bed		[bæ]
melon		[minəm]	empty		[hami]
pen		[bi] ~ [bæ̃n]			

TABLE 4

/ɛl corresponds to the basic categories /i/ and / æ /. Moreover, these two correspondence sets reveal a further pattern.

The occurrence of/i/ or / æ / in the correspondence set for /ɛl seems to be conditioned by the sonorant property of the post vowel consonant. Two realization rules might be postulated to take account of this conditioning environment. One of these rules would realize /ɛl as /i/ before a sonorant consonant. The other rule would realize /ɛl as / æ / before an obstruent consonant. Rules of such a form might be conflated in the following manner:

2. $$\begin{bmatrix} V \\ -high \\ -low \\ -back \\ -tense \end{bmatrix} \longrightarrow \begin{bmatrix} +tense \\ \alpha high \\ -\alpha low \end{bmatrix} / __ \begin{bmatrix} C \\ \alpha sonorant \end{bmatrix}$$

What may already have been noticed in Table 4 are the exception forms to the above rules. The form [bæ̃ n] in particular is an exception to rule 2. However, this form appeared toward the end of the time period represented by the data. In a subsequent section of this discussion [b æ̃n] and other instances of what might be called "anticipatory" forms will be dealt with. The "anticipatory" forms aside, other exceptional forms in the data will be treated as phonological idioms, a classification developed in the child phonology literature to account for forms which do not abide by postulated rules.

Before proceeding to a discussion of other mid vowel categories, a reference to Velten (1943) should be made. Recall that the adult category /ɛ/ showed two correspondence sets in Velten (1943). It corresponded to /u/ before obstruent consonants and to /a/ before sonorant consonants. What is notable about Velten's (1943) analysis is the role sonorant consonants play in conditioning the reflex of lɛl compared to their role in the present study. Here, lɛl corresponds to /i/ before sonorant consonants and to / æ/ before obstruents.

Compared to the two correspondence sets for the adult forms containing lɛl, the forms with lol reveal what appear to be three correspondence sets. Table 5 contains some of the forms under consideration.

lol : /au/	
soap	[saw]
cold	[gaw]
hello	[iyaw]

lol : /u/	
boat	[bu]
croak	[bu]
floor	[fu] ~ [ʰu]
float	[fu wa]
boy	[bu]

lol : /a/	
horsie	[habi] ~ [haw]
horn	[ham]
overalls	[abi]

lol : /o/	
no	[no] ~ [now] ~ [naw]
more	[mo]
nose	[nu] ~ [nyu]
notice	[nu]
toe	[du]
robe	[ro]

TABLE 5

As can be observed here, /o/ corresponds to the categories /u/, /au/, and apparently /a/. One can conclude from Table 5 that the particular vowel category corresponding to /o/ is conditioned by the preceding consonant. Accordingly, /o/ corresponds to /u/ after /b,f/, to /a/ after /h/ and to /au/ after any other consonant. The three realization rules capturing the regularity of these correspondence sets might be stated in the following form:

3. $\begin{bmatrix} V \\ +back \\ -high \\ -low \\ -labial \end{bmatrix} \rightarrow [+high] \; / \; \begin{bmatrix} C \\ +labial \end{bmatrix} ____$

4. $\begin{bmatrix} V \\ -back \\ -high \\ -low \\ +labial \end{bmatrix} \rightarrow [+low] \; / \; \begin{bmatrix} C \\ +low \end{bmatrix} ____$

5. $\begin{bmatrix} V \\ +back \\ -high \\ -low \\ -labial \end{bmatrix} \rightarrow [+low \quad +high] \; / \; C ____$

Rules 3,4, and 5 must be sequentially ordered such that rule 5 does not occur before rule 3 or 4. Another aspect of the above rules to be noted is that they employ the controversial features [labial] and [low]. These features were used in order to capture what seem to be assimilatory processes in these and subsequent rules.

To return to Table 5 and a point perhaps already noted, consider the exception forms to rules 3, 4, and 5. A notable exception involves the forms with an initial nasal, [no] and [mo]. Since these forms represent the commonly used words no and more respectively, one might expect such words not to be governed by postulated rules. Such cases appear to be genuine phonological idioms.

Additional support for the status of the forms [no] and [mo] as phonological idioms can be gained from a consideration of other nasal initial forms in Table 5. None of these other forms pattern like [no] and [mo]. The other nasal initial forms create a problem of their own, that is, their status as phonological idioms or as "anticipators" of a new pattern is open. Nonetheless, if the forms [no] and [mo] can be considered as idioms, then the status of the four basic vowel categories remains intact.

Other exception forms in Table 5 do not pose such a serious threat to the four basic categories. Some of the exception forms reveal the static property of the realization rules. Those forms with initial /h/ reflect what may be a rule change in progress where post-/h/ vowels correspond to /au/. Still other exception forms were recorded in the data only once, suggesting that their status was not yet fixed.

The final set of correspondences for mid vowel categories to be discussed here involve |ʌ| . Table 6 contains correspondence sets pertaining to this adult category. According to the data in Table 6,

|ʌ| : /i/	
work	[wi]
dirt	[di]
fur	[fi]

|ʌ| : /a/	
up	[ha]
mud	[ma]
brush	[ba]
come	[gam]

|ʌ| : /u/	
bird	[bu]
purr	[bu]
curtain	[Ku]

TABLE 6

there appear to be two major classes of correspondence sets. One set contains | ʌ | in conjunction with |r| and the other contains | ʌ | in isolation.

The two correspondence sets for |ʌ | pattern differently. The conjunctive set, | ʌ| plus |r|, appears to pattern somewhat like the |o| set of correspondences. That is, the place of articulation of the preceding consonant appears to condition which of C's vowels will appear in the correspondence set. In this case |ʌ | corresponds to /u/ after |b| and to /i/ after other consonants. Such a pattern does not entirely parallel that found for |o| because of the /i/ reflex. The |ʌ|:|u| correspondence after /b/, on the other hand, is a strong parallel suggesting that perhaps the labial properties of /b/ and /f/ have a unique control over the mid back vowels.

Based on the correspondence set for conjunctive |ʌ |, the following realization rules might be postulated.

6. $$\begin{bmatrix} V \\ +back \\ -labial \\ -high \\ -low \end{bmatrix} \rightarrow \begin{bmatrix} +labial \\ +high \end{bmatrix} / \begin{bmatrix} C \\ +labial \\ -continuant \\ +voice \end{bmatrix} __ \begin{bmatrix} C \\ -lateral \\ +sonorant \\ -nasal \end{bmatrix}$$

7. $\begin{bmatrix} V \\ +back \\ -high \\ -low \\ -labial \end{bmatrix} \longrightarrow \begin{bmatrix} +high \\ -back \\ +tense \end{bmatrix} / \begin{bmatrix} C \\ -labial \end{bmatrix} __ \begin{bmatrix} C \\ -lateral \\ +sonorant \\ -nasal \end{bmatrix}$

The correspondence set for | ʌ| in isolation is much less variable than that for the conjunctive form. In isolation, as Table 6 suggests, | ʌ| corresponds to /a/ in all environments. A realization rule of the following form might thus be constructed to account for this correspondence set:

8. $\begin{bmatrix} V \\ +back \\ -high \\ -low \\ -labial \end{bmatrix} \longrightarrow [+low]$

A comparison of the structure of the eight realization rules postulated thus far reveals their formal dissimilarity. Perhaps the most noticeable structural difference among the context sensitive realization rules is the position of the conditioning consonant segment. Either a preceding or following consonant, or sometimes both, condition the outcome of the realization rules for | ɛ |, |ʌ | and |o|.

In addition to the position of the conditioning consonant, a difference among the realization rules can be found in the status of the conditioning consonant. Certain of the rules refer to consonant properties existing at the underlying level of representation. Such is the case for rule 2 which refers to underlying sonorant consonants. Other rules refer to a conditioning consonant that is a derived segment. C's form [bu] in Table 5, which is derived from croak, appears to be an instance where the rules refer to a derived segment.

A final difference among the realization rules, at least to the extent to which they are formulated here, seems to be the apparently diverse processes they capture. Certain of the rules acting on the categories |o| and |ʌ| , where the feature [labial] is used, appear to capture an assimilation process. The rules acting on | e | and | ʌ | , in contrast, do not appear to capture assimilation processes since they are context free rules. Even the rules acting on | ɛ| which refer to sonorant and obstruent consonants do not seem to capture assimilation processes. Such realization rules that are structurally dissimilar and that capture different processes appear to exist independently of one another in the phonological system under investigation.

Before proceeding to discuss the supposed independence of the

realization rules, consider other stages in C's phonological development. Table 7 contains correspondence sets for the mid vowel categories for the period 15-1/2 to 17-1/2 months (Stage I). What seems to be

/ɛ/ : [ɛ]	/o/ : [o]	/ʌ/ : [ʌ]
hair [hɛ]	horsie [owi] ~ [howi]	bump [bʌ]
belt [bɛ:]	snow [no]	bird [dabʌ]
wet [wɛ] ~ [wæ] ~ [we]	coke [go]	button [ba]
bear [bi] ~ [bɛ]	soap [so]	prefix unit [dʌ]
	mole [mo]	

/a/ : [a]

open [abi]
horsie [ab] ~ [hawi]

TABLE 7

particularly revealing about the data in Table 7 is its apparent contrast to Tables 2 through 6 which represent Stage II from 17-1/2 to 20 months. The data in Table 7 suggest that the correspondences /o/:[o], /ɛ/ : [ɛ] and perhaps even /ʌ/: [ʌ] existed prior to the period beginning at 17-1/2 months (Stage II). It would appear, therefore, that the mid vowel categories were a part of C's phonological system in Stage I but failed to appear in Stage II. The overall pattern of development observed for the mid vowel categories from 15-1/2 to 20 months might thus be characterized as a process of regression.

A parenthetical point to be noted about Table 7 are C's forms for open, horse, wet, and bear. These forms appear to anticipate Stage II. They appeared for the first time during the final two or three weeks of Stage I and will be discussed later.

The overall pattern of correspondence sets for Stage I and Stage II suggest that a change occurs in the status of the mid vowel categories. The correspondence sets from the next stage, Stage III, suggest that the specification of the realization rules also changes. Stage III includes the 21st month of development only, since the availability of phonological data after 21 months was extremely limited.

The correspondence sets from Stage III for each of the adult mid vowel categories /e/, /ɛ/, /o/, /ʌ/ can be found in Tables 8, 9, and

0. It is apparent from Table 8 that C's development during Stage III is

ɪɛ ɪ : /i/		ɪɛ ɪ : / æ /	
there	[wi]	pen	[p^{h}ãn]
airplane	[hibi]	hen	[hã n]
hair	[hi]	friend	[Φã n]
		again	[gin]
ɪɛ ɪ : / æ/		ɪɛ ɪ : /æ /	
wet	[wæ] ~ [wæ t^{h}]	shell	[sæ]
egg	[hæ]	help	[hæ]
Jeanette	[næ]		
deck	[gæ k^{h}]		
get	[gi]		

TABLE 8

ɔ ɪ : / au /		ɪ o ɪ : /u/	
soap	[saw]	bowling	[buway]
cold	[K^{h}aw]	boy	[buwi]
door	[t^{h}aw]	fold	[Φu]
horsie	[habi]	ɪoɪ : /o /	
open	[habi]	dough	[do]
boat	[p^{h}aw] ~ [b^{h}aw]	comb	[Koum]
broken	[baw]		

TABLE 9

ɪeɪ : /i/		ɪʌɪ : /ə/	
baby	[bibi]	up	[ha]
case	[k^{h}ɪ]	sun	[san]
bacon	[bini]	cup	[$k^{h}up^{h}$]
tape	[t^{h}ɪ·p^{h}]	cover	[k^{h}a]
		butter	[bati]

ɪʌɪ : /u/

purse	[p^{h}u]
bird	[budi] ~ [bu·d]
curl	[k^{h}ui]

TABLE 10

consistent with the basic categories postulated for Stage II. | ɛ | corresponds to /i/ and / æ/ as before. However, the adult forms composing these two correspondence sets are no longer consistent with the correspondence sets of Stage II. For instance, | ɛ | corresponds to / æ / when followed by |n| or |l| in Stage III compared to the | ɛ| : /i/ correspondence in the same environment for Stage II. | ɛ | followed by /r/ still appears to correspond to /i/. The conditioning environment for the realization rule governing | ɛ| appears to be in the process of becoming respecified in Stage III so that one, rather than two, conditioning environments will be specified. The rule might thus be thought of as becoming more general.

The correspondence sets in Table 9 suggest that the development of the category |o| in Stage III maintains the integrity of the basic vowel categories postulated in Stage II. As with |ɛ |, the correspondence sets for |o| are retained in Stage III, but the adult forms constituting those sets appear to be changing. For instance, C's forms for boat and broken have changed from [bu] to [baw], suggesting that rule 3 is giving way to rule 5. In addition, a bilabial fricative has become an apparent conditioning consonant for the |o|:/u/ correspondence. As compared to their earlier form in Stage II, the rules governing |o| are perhaps undergoing a transition in the direction of less specific, more general rules as well.

The final correspondence sets for Stage III to be considered are those for |e | and |ʌ |. In Table 10 are presented the meager data available for these two categories. (The reason for their paucity may be that no change from earlier forms was noticed by C's mother). In the context of Tables 8 and 9, Table 10 appears to support the contention that the basic categories postulated for Stage II are retained in Stage III. Major changes affecting the conditions or the output of the rules governing |e | and |ʌ | are not found in the data however.

The overall pattern of development with regard to the mid vowel categories form 15-1/2 to 21 months can now be summarized: An initial period, for which correspondence set congruence between adult and child mid vowel categories apparently exists, occurs from 15-1/2 to 17-1/2 months. In a subsequent period, from 17-1/2 to 21 months, the correspondence sets between adult and child mid vowels show noncongruence categories. Exceptions to this pattern of development are few and can be accounted for by appeal to the notion phonological idiom. Realization rules, posited to capture the regular correspondence between the adult and child vowel categories, appeared to be rather diverse in formal structure and to capture distinct processes. The realization rules were thus considered to be independent developments motivated by independent criteria.

In contrast to the conclusion that the realization rules are independent of one another, the following discussion will suggest that a general principle may govern these apparently independent rules. In

addition, a reevaluation of the status of the mid vowel categories in Stage I will be tentatively set forth.

The phonological principle which may be governing the seemingly independent realization rules can be found in Jakobson (1939, 1956 and 1968). According to Jakobson, the sequence of phonological development obeys the principle of maximal contrast. It follows from Jakobson's principle that the segments /a/ and /p/ are acquired first in development since they contrast a maximum acoustic energy output with a minimum energy output. At later stages of development /i/ or /u/ will develop as a degree of aperture contrast with /a/, and /i/ and /u/ will develop as a front/back contrast.

In the past, Jakobson's (1968) principle of maximal contrast has been restricted to discussions of the first three or perhaps four vowels. It has been assumed that the principle argues for the acquisition of an /e/:/a/:/i/ contrast prior to the acquisition of an / æ/:/a/:/i/ contrast. However, it may be that the principle of maximal contrast applies to the data in Stage II and Stage III. That is, if the principle of maximal contrast is reinterpreted in terms of the articulatory features high, low and back, then the four basic categories postulated for Stage II and III seem to represent a probable stage in the acquisition of vowel categories in English. Given such a reinterpretation of the principle of maximal contrast, how can this principle be linked to the seemingly independent nature of the realization rules and, therefore, to the contrasting correspondence sets of Stage I and Stage II?

The potential link between the principle of maximal distance and the seemingly independent realization rules might be found in the formal mechanism which embodies the principle of maximal contrast. Such a mechanism has been discussed in recent generative theory under the designation "surface phonetic constraint."

Shibatani (1973) reintroduced the notion of constraints on distribution and combination of segment units at a level of phonological representation other than the underlying or morphophonemic level. According to Shibatani (1973), segments at this non-underlying level are fully specified in terms of binary feature notation. Constraints stated at such a level can account, among other things, for native speaker intuitions of possible but non-occurring lexical items. In German, for instance, possible lexical items must terminate with voiceless obstruent consonants even though the corresponding underlying obstruents may be specified as voiced. Clayton (1976) extends the discussion of surface constraints by claiming that constraints at the underlying level of representation can not be empirically motivated.

Lorentz (1976) has applied the notion of surface phonetic constraint to one developing, but language-delayed, phonological system. Lorentz's (1976) analysis focuses on the constraints which appear to govern word initial fricative-stop consonant clusters. In general, the

process affecting these clusters seems to be captured by assimilation rules. One of the clusters, /sK/, however, appears to be governed by a metathesis rule which outputs /Ks/. Lorentz (1976) claims that analysis of the data in terms of surface phonetic constraints allows a more general characterization of the cluster processes. That is, by postulating a surface phonetic constraint of the following form, both the assimilation and metathesis processes can be viewed as having a common motivation.

$$\sim [\ \#\ [+\text{fricative}]\quad [-\text{liquid}]\ ]$$

Following Lorentz's (1976) analysis of a non-adult phonological system by means of a surface phonetic constraint, it may prove fruitful to consider a surface phonetic constraint as the formal embodiment of the principal of maximal contrast. Recall the formally independent realization rules postulated for Stages II and III. By postulating a surface phonetic constraint which prevents the appearance of mid vowels, to which rules 1 through 7 above are subject, one can reveal the non-independent status of the realization rules.

A.
$$\sim \begin{bmatrix} V \\ -\text{high} \\ -\text{low} \end{bmatrix}$$

Since realization rules 1 through 7 are motivated by surface constraint A, one can capture their functional relationship. The primary function of the realization rules, it seems, is to maintain a maximal contrast among the vowels in C's productive output by preventing the appearance of mid vowels.

A crucial aspect of the notion surface phonetic constraint that has been avoided till now involves the level of representation at which the constraints apply. Surface phonetic constraints in Shibatani's (1973) terms apply at a non-underlying level of representation where segments are specified in terms of binary features. Such a level does not appear to be the level of phonetic representation since segment features would then be represented by integer specifications.

The output of the realization rules, the basic categories, must also be stated in terms of binary features. Smith (1973) clearly states that the output of the realization rules represents a level prior to the application of phonetic rules (i.e., integer specification rules). It would appear, therefore, that the level at which surface phonetic constraints operate, and the level at which the basic categories are specified are not incompatible. Indeed such a level does not appear distinct from that level in adult phonological theory which results from the application of phonological rules. Shane (1971) has argued that this level yields the traditional notion of the phoneme.

If the categories of C's phonological system can thus be con-

sidered phonemes, then it is precisely these phoneme units which appear to change from Stage I to Stage II. Since surface constraint A is stated in terms of features found at the phonemic category level, the features [-high, -low] must be available in Stage II to the phonemic level of representation. One might assume, therefore, that the category /o/, for instance, is analyzed into feature notation at Stage II and Stage III.

Since the category /o/ at Stages II and III is specified in terms of binary features, it might be considered an analyzed form. It is not clear, however, that /o/ has an equal category status in Stage I. Assume that the principle of maximal contrast and hence surface constraint A govern phonological development from the initial stages. The mid vowel categories in Stage I could then be considered as forms which violate constraint A, or as unanalyzed forms. (Unanalyzed in the present context means lacking phonological feature specifications). The first choice appears unattractive since violation of constraint A must in some manner be motivated. Choice two appears somewhat more attractive since such an analysis may parallel analyses of development in other areas of language acquisition.

The notion of unanalyzed form is found in the acquisition of syntax and semantics. The classic illustration of an unanalyzed form can be found in the sequential development of strong verbs in English speaking children, e.g., broke, breaked, broke. The initial broke form is usually considered an unanalyzed form from the child's point of view. Only after a stage in which the constituents of broke (break plus past tense) appear in a rule governed pattern is broke accorded the status of an analyzed form.

The data in the present study suggest a line of phonological development parallel to that found in syntax. In the present study /o/, for instance, would be accorded phonemic status only after it was subject to the rule governed pattern in Stages II and III motivated by surface constraint A. If such a tentative hypothesis can be maintained, the phonemic category status of the mid vowel segments in C's phonological system is determined by their uniform compliance with surface constraint A. Note that the above hypothesis is concerned with surface categories and not with morphophonemic or underlying categories, as discussed in Braine (1974). Finally, it may be significant to point out that the above hypothesis, contrary to Leopold (1953), suggests that the absence of a sound category, rather than its presence, may act as a signal of phonemic category status.

From the preceding discussion of the development of the mid vowel categories in one child, two tentative conclusions were arrived at. The first of these conclusions suggests that the postulated realization rules, which attempted to account for the regular correspondence among the adult-child vowel categories, are functionally related. The second conclusion, dependent on the overall pattern of mid vowel development from Stage I to Stage III, suggests that the behavior of the mid vowel categories can be accurately described with the term regression. Although

these conclusions are based solely on the development of vowel categories, they appear to gain additional support when viewed in the wider context of phonological acquisition studies.

The notion of regression in phonological development has been explicitly addressed by Ferguson and Farwell (1975) and Smith (1973). In Ferguson and Farwell (1975) the notion of regression is derived from phonological productions of three English speaking children while they were acquiring their first fifty words. By examining word initial consonants throughout this period, it was found that many of the children's earliest forms were produced accurately. More important though, Ferguson and Farwell (1975) found that as development continued the accurate forms were either reduced or selectively avoided. The similarity between this finding and the regression status of the mid vowel categories from Stage I to Stage II in the present study seems genuine.

The primacy of lexical learning in phonological change is another issue raised in Ferguson and Farwell (1975), but also discussed in Menn (1973). According to Ferguson and Farwell (1975), the source of phonological change is not found in a phonological system, but rather in a lexical item. Such a perspective on the source of change appears compatible with Menn's (1973) discussion of rule emergence. Menn (1973) found that phonological rules were acquired hesitatingly, but equally important, phonological rules did not initially apply to their full natural domain. Accordingly, she claims that a rule is defined by an initial instance or occurrence in a word and spreads throughout its domain of application from that instance.

The idea of locating the source of phonological rules in lexical items appears to find support in the present study. Recall the anticipatory forms given slight attention in earlier sections of this discussion, in particular the forms [bi], and [w æ] for bear and wet respectively in Stage I, and [b æ̃ n] for pen in Stage II. Each form under consideration appears to abide by a rule that accounts for a regular sound correspondnece at a later stage. Following the argument of Ferguson and Farwell (1975) and Menn (1973), the earliest reported instances of these anticipatory forms would be the source of a realization rule. It would seem, therefore, that the collected data assume a cohesiveness that might go unnoticed, if the anticipatory forms were considered as mere phonological idioms.

The functional unity of the realization rules and the stage of category regression they apparently reflect appear most compatible with the theoretical position on phonological development found in Kiparsky and Menn (1977). In addition to detailing their own theoretical position on phonological acquisition, Kiparsky and Menn (1977) criticize two major theories of phonological development for their inherent determinism.

From the perspective of Kiparsky and Menn (1977), the theories of

Jakobson (1968) and Stampe (1969) are deterministic in that each posits a filter, or a set of constraints on universal grammar, which derives child speech from adult speech. The determinism in Jakobson's (1968) theory apparently arises from its view of phonological acquisition as the successive unfolding of a set of feature contrasts arranged in a strict hierarchy. In Stampe's (1969) theory, on the other hand, the determinism apparently stems from its notion of phonological development as a continuous suppression or limitation of innate processes. In both theoretical approaches according to Kiparsky and Menn (1977), the primary emphasis appears to be placed on inherent limitations or restrictions of the human phonological capacity.

Kiparsky and Menn (1977) acknowledge the inherent limitations of the human phonological capacity, but they argue that such emphasis on inherent limitations fails to take account of the inventive nature of the child. The acquisition of a phonological system for Kiparsky and Menn (1977) is a problem-solving activity from the earliest stages guided by the child's innate hypothesis-testing capacity. A major source of evidence for their theoretical position comes from selective avoidance, the exclusion of words containing certain sounds, and from the exclusion of certain sound units in production. One instance of selective avoidance is the so-called third position problem. A child's speech can often be characterized by the presence of stop consonants from two of the three major places of articulation. In this same child's speech, however, adult words containing the missing stop consonant will often fail to appear. According to Kiparsky and Menn (1977), selective avoidance is one of many solutions a child may employ in order to deal with the problems of phonological acquisition.

The interpretation of the data in the present study can be favorably viewed in terms of Kiparsky and Menn's (1977) notion of phonological acquisition as a problem-solving activity. Constraint A appears to pose a particular problem for phonological output to which the formally dissimilar realization rules provide a solution. Although an interpretation in these terms is possible, it is important to emphasize that phonological acquisition, as interpreted in the present study, appears to be characterized by an interaction of the inventive nature of the child and the inherent constraints on the phonological category system.

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